JC05 Rec'd PCT/PTO 19 MAR 2002

FORM PTO-1390 (REV. 12-2001)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER BRI-00063		U.S. APPLICATION NO. (If known, see 37 CFR 1.5 10/088767
INTERNATIONAL APPLICATION NO. PCT/AU00/01142	INTERNATIONAL FILING DATE 20 September 2000	PRIORITY DATE CLAIMED 20 September 1999

TITLE OF INVENTION
DIRECT CURRENT MOTOR CONTROL CIRCUIT

APPLICANT(S) FOR DO/EO/US
Andrew Churchett, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

Copy of the Patent Application and Drawings
(International Application Published Under the Patent Cooperation Treaty)
Express Mailing Certificate No. EU 065 973 500 US
Return Receipt Postcard

10/088767

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U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/088767	PCT/AU00/01142	BRI-00063

21. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1040.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1,040.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	11 - 20 =	0	x $18.00	$	
Independent claims	1 - 3 =	0	x $84.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $280.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 1,040.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$	
SUBTOTAL =				$ 1,040.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 1,040.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 40.00	
TOTAL FEES ENCLOSED =				$ 1,080.00	
				Amount to be refunded:	$
				charged:	$ 1,080.00

a. ☐ A check in the amount of $ ________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 501612 in the amount of $ 1,080.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 501612. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

Philip R. Warn
NAME

32775
REGISTRATION NUMBER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the National Phase Application in the United States
of International Patent Application No. PCT/AU00/01142
Filed September 20, 2000

Application No.:	Not assigned yet
Filing Date:	Not assigned yet
Applicant:	Churchett et al.
Group Art Unit:	Not assigned yet
Examiner:	Not assigned yet
Title:	DIRECT CURRENT MOTOR CONTROL CIRCUIT
Attorney Docket:	BRI-00063

PRELIMINARY AMENDMENT

Commissioner of Patents & Trademarks
Washington, D.C. 20231

Sir:

Prior to examination of the present application, please consider the following.

Please amend the above-identified application as follows.

IN THE SPECIFICATION

The specification has been rewritten as follows:

On pages 2-3, the Brief Description of the Invention section has been rewritten as follows:

In a broad aspect of the invention, a motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein the motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to the motor, the

motor control circuit comprising, a pair of unipolar control circuits wherein at least one of the unipolar control circuits is connected between a respective current source and a current input to the motor wherein at least one of the unipolar control circuits is adapted to operate the motor in one of the two directions,

a motor control circuit wherein each of the unipolar control circuits are substantially identical,

a motor control circuit wherein at least one of the unipolar control circuits further comprises,

a solid state switch located between the motor current input and the source of direct current wherein the degree to which the solid state switch allows current to flow to the motor is controlled by an input bias signal to the switch,

a current limiting member for adjusting said input bias signal according to the current flowing through the motor, such that the solid state switch adjusts the input bias to the solid state switch such that less current flows through the motor when a predetermined period of current limiting has occurred, and

a motor control circuit wherein the current limiting member further comprises a temperature compensation circuit.

On Page 4, the last full paragraph has been rewritten as follows:

In the example of an outside rear view mirror housing which is foldable relative to the vehicle body between a folded position and a lateral position, a single electric motor can be connected to a mechanical member for translating the rotational motion of the motor's shaft into a movement of the mirror housing between the described positions.

On Page 5, the fifth full paragraph has been rewritten as follows:

However, this is but one preferred characteristic of the motor control arrangement for determining when to switch off or substantially reduce power to the motor.

On Page 7, the fourth full paragraph has been rewritten as follows:

Current flows through the diode of Q4 (a parasitic diode which is available in transistors of this general type), through the motor RM, through Q1 and through current

sense resistors R8 and R9. This diode provides reverse current blocking and over voltage protection but in other circuit configurations, a Zener diode of suitable characteristics could be across the output devices. In the preferred embodiment solid state switches Q1 and Q4 are each a Metal Oxide Silicon Field Effect Transistor (MOSFET) semi-conductor transistor device.

On Pages 8-9, the paragraph spanning the bottom of page 8 to the top of page 9 has been rewritten as follows:

The increase in current through the thermistor R2 with increasing temperature will cause an increased voltage across R7. This voltage reduces the voltage appearing across the base emitter junction of Q3. The effect is to off-set the reduction in base emitter voltage required by Q3 with increased temperature. R7, R2 and R1 are chosen to give a best fit current versus temperature curve. R1 limits the maximum current that can flow when very high temperatures are experienced by the system. It is worth noting that temperature compensation can be used to produce other than flat responses to accommodate for material softening in the mechanics.

On Page 11, the first line has been rewritten as follows:

What is claimed is:

After the claims, the following text has been inserted:

<u>Abstract</u>

A motor control circuit for a direct current electric motor has a pair of direct current inputs supplied respectively from negative and positive current sources. The direction of travel of the rotor of the motor is determined by the polarity of the current supplied to it. A new motor control circuit includes a pair of substantially identical unipolar control circuits. Each of the unipolar control circuits being connected between a respective current source and a current input to the motor wherein a respective unipolar control circuit is adapted to operate the motor in one of the two directions.

Each of the unipolar control circuits includes a solid state switch located between a motor current input and the source of direct current. The degree to which the solid state switch allows current to flow to the motor is controlled by an input bias signal to the switch. Current limiting for adjusting the input bias signal according to the current flowing through the motor is provided in one way of controlling the motor movement. The switch adjusts the input bias to the solid state switch such that less current flows through the motor when a predetermined period of current limiting has occurred. Also a current detection can be used to detect the magnitude of current being drawn through the motor and if the magnitude exceeds a predetermined level for a predetermined time, the input bias signal to the switch can be reduced.

<u>IN THE CLAIMS</u>

The claims have been rewritten as follows:

1. (Amended) A motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein said motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to said motor, said motor control circuit comprising:

a pair of unipolar control circuits wherein at least one of said unipolar control circuits is connected between a respective current source and a current input to said motor, wherein at least one of said unipolar control circuits is adapted to operate said motor in one of said two directions.

2. (Amended) A motor control circuit according to claim 1 wherein each of said unipolar control circuits is substantially identical.

3. (Amended) A motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises:

a solid state switch located between said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

a current limiting member for adjusting said input bias signal according to the current flowing through said motor, such that said solid state switch adjusts said input bias to said solid state switch such that less current flows through said motor when a predetermined period of current limiting has occurred.

4. (Amended) A motor control circuit according to claim 3 wherein said current limiting member further comprises a temperature compensation circuit.

6. (Amended) A motor control circuit according to claim 3 wherein said solid state switch member is arranged to not operate said motor when said current limiting is occurring for a further predetermined period of time.

7. (Amended) A motor control circuit according to claim 3 wherein said solid state switch member is arranged to not operate said motor when current drawn by said motor exceeds a predetermined threshold current for a predetermined period of time.

8. (Amended) A motor control circuit according to claim 3 wherein said current limiting member comprises:

a motor current sensing circuit comprising a shunt resistor arranged to carry a

proportion of the current flowing through said motor and provide a respective voltage to the base of a bipolar transistor which is arranged to turn on at a predetermined voltage level representative of the current flowing through said motor at which it should be switched off, such that said bipolar transistor turns on when said predetermined voltage level is reached and which decreases the input bias to said solid state switch to lessen the current through said motor.

9. (Amended) A motor control circuit according to claim 1 wherein at least one of said pair of unipolar control circuits conducts current to complete the circuit to allow said motor to operate.

10. (Amended) A motor control circuit according to claim 1 wherein at least one of said unipolar control circuits further comprises:

a solid state switch located between said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said solid state switch,

a current detection member to detect the magnitude of current being drawn through said motor and if said magnitude exceeds a predetermined level for a predetermined time reduce said input bias signal to said switch.

REMARKS

Claims 1-4 and 6-10 have been amended. Support for these amendments can be found throughout the specification and drawings, as originally filed.

The specification has been amended to correct minor typographical, grammatical and syntax errors. The Applicants aver that no new matter has been added to the instant application.

Additionally, the Applicants have provided an Abstract section to the instant application. A separate sheet containing the Abstract is submitted herewith. The Applicants aver that no new matter has been added to the instant application.

The Applicants respectfully request entry of the above amendments. The Applicants submit that no new matter has been added. The Applicants respectfully submit that the application is in condition for substantive examination, and such examination is respectfully requested.

Respectfully submitted,

WARN, BURGESS & HOFFMANN, P.C.
Attorneys for Applicants

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Dated: March 19, 2002

PRW/PHS/phs

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

On pages 2-3, the Brief Description of the Invention section has been rewritten as follows:

In a broad aspect of the invention, a motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein [said] the motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to [said] the motor, [said] the motor control circuit comprising, a pair of unipolar control circuits wherein [a respective one] at least one of [each] the unipolar control circuits is connected between a respective current source and a current input to [said] the motor wherein [a respective] at least one of the unipolar control [circuit which] circuits is adapted to operate [said] the motor in one of [said] the two directions,

a motor control circuit [according to claim 1] wherein each of [said] the unipolar control circuits are substantially identical[.],

a motor control circuit [according to claim 1] wherein [each of said] at least one of the unipolar control circuits further comprises,

a solid state switch located between [a said] the motor current input and [said] the source of direct current wherein the degree to which [said] the solid state switch allows current to flow to [said] the motor is controlled by an input bias signal to [said] the switch,

a current limiting [means] member for adjusting said input bias signal according to the current flowing through [said] the motor, such that [said] the solid state switch [switching means] adjusts [said] the input bias to [said] the solid state switch such that less current flows through [said] the motor when a predetermined period of current limiting has occurred, and

a motor control circuit [according to claim 3] wherein [said] the current limiting [means] member further comprises a temperature compensation circuit.

On Page 4, the last full paragraph has been rewritten as follows:

In the example of an outside rear view mirror housing which is foldable relative to the vehicle body between a folded position and a lateral position, a single electric motor can be connected to a mechanical [means] member for translating the rotational motion of the motor's shaft into a movement of the mirror housing between the described positions.

On Page 5, the fifth full paragraph has been rewritten as follows:

However, this is but one preferred [characteristics] characteristic of the motor control arrangement for determining when to switch off or substantially reduce power to the motor.

On Page 7, the fourth full paragraph has been rewritten as follows:

Current flows through the diode of Q4 (a parasitic diode which is available in transistors of this general type), through the motor RM, through Q1 and through current sense resistors R8 and R9. This diode provides reverse current blocking and over voltage protection but in other circuit configurations, a Zener diode of suitable characteristics could be across the output devices. In the preferred embodiment solid [states] state switches Q1 and Q4 are each a Metal Oxide Silicon Field Effect Transistor (MOSFET) semi-conductor transistor device.

On Pages 8-9, the paragraph spanning the bottom of page 8 to the top of page 9 has been rewritten as follows:

The increase in current through the thermistor R2 with increasing temperature will cause an increased voltage across R7. This voltage reduces the voltage appearing across the base emitter junction of Q3. The effect is to off-set the reduction in base emitter voltage required by Q3 with increased temperature. R7, R2 and R1 are chosen to give a best fit current versus temperature curve. R1 limits the maximum current that can flow when very high temperatures are experienced by the system. It is worth noting that temperature compensation can be used to produce other than flat responses to accommodate for material softening [etc] in the mechanics.

On Page 11, the first line has been rewritten as follows:

[THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS] What is claimed is:

IN THE CLAIMS

The claims have been rewritten as follows:

1. (Amended) A motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein said motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to said motor, said motor control circuit comprising[,]:

a pair of unipolar control circuits wherein [a respective] at least one of [each] said unipolar control circuits is connected between a respective current source and a current input to said motor, wherein [a respective] at least one of said unipolar control [circuit which] circuits is adapted to operate said motor in one of said two directions.

2. (Amended) A motor control circuit according to claim 1 wherein each of said unipolar control circuits [are] is substantially identical.

3. (Amended) A motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises:

a solid state switch located between [a] said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

a current limiting [means] member for adjusting said input bias signal according

to the current flowing through said motor, such that said [switching means] solid state switch adjusts said input bias to said solid state switch such that less current flows through said motor when a predetermined period of current limiting has occurred.

4. A motor control circuit according to claim 3 wherein said current limiting [means] member further comprises a temperature compensation circuit.

6. (Amended) A motor control circuit according to claim 3 wherein said solid state switch [means] member is arranged to not operate said motor when said current limiting is occurring for a further predetermined period of time.

7. (Amended) A motor control circuit according to claim 3 wherein said solid state switch [means] member is arranged to not operate said motor when current drawn by said motor exceeds a predetermined threshold current for a predetermined period of time.

8. (Amended) A motor control circuit according to claim 3 wherein said current limiting [means] member comprises:

a motor current sensing circuit comprising a shunt resistor arranged to carry a proportion of the current flowing through said motor and provide a respective voltage to the base of a bipolar transistor which is arranged to turn on at a predetermined voltage level representative of the current flowing through said motor at which it should be switched off, such that said bipolar transistor turns on when said predetermined voltage level is reached and which decreases the input bias to said solid state switch to lessen the current through said motor.

9. (Amended) A motor control circuit according to claim 1 wherein [each of the other] <u>at least one</u> of said pair of unipolar control circuits conducts current to complete the circuit to allow said motor to operate.

10. (Amended) A motor control circuit according to claim 1 wherein [each] <u>at least one</u> of said unipolar control circuits further comprises<u>:</u>

a solid state switch located between [a] said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said <u>solid state</u> switch,

<u>a</u> current detection [means] <u>member</u> to detect the magnitude of current being drawn through said motor and if said magnitude exceeds a predetermined level for a predetermined time reduce said input bias signal to said switch.

Abstract

A motor control circuit for a direct current electric motor has a pair of direct current inputs supplied respectively from negative and positive current sources. The direction of travel of the rotor of the motor is determined by the polarity of the current supplied to it. A new motor control circuit includes a pair of substantially identical unipolar control circuits. Each of the unipolar control circuits being connected between a respective current source and a current input to the motor wherein a respective unipolar control circuit is adapted to operate the motor in one of the two directions. Each of the unipolar control circuits includes a solid state switch located between a motor current input and the source of direct current. The degree to which the solid state switch allows current to flow to the motor is controlled by an input bias signal to the switch. Current limiting for adjusting the input bias signal according to the current flowing through the motor is provided in one way of controlling the motor movement. The switch adjusts the input bias to the solid state switch such that less current flows through the motor when a predetermined period of current limiting has occurred. Also a current detection can be used to detect the magnitude of current being drawn through the motor and if the magnitude exceeds a predetermined level for a predetermined time, the input bias signal to the switch can be reduced.

10/088767
JC13 Rec'd PCT/PTO 19 MAR 2002
PCT/AU00/01142

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DIRECT CURRENT MOTOR CONTROL CIRCUIT

This invention relates to a vehicle mirror motor control used in moving a mirror between an in-use position and a parked position, in particular to a circuit which effectively turns off electric current to the motor as the mirror reaches the end of its intended travel when being folded back or moved to an operative position. However, it will be appreciated that such a circuit is useable in other apparatus which use electric motors and require an efficient and cost effective turn-off of the kind described.

BACKGROUND

A side mounted vehicle rear view mirror is normally pivotally mounted to a vehicle mounting bracket so that it can be forwardly or rearwardly rotated relative to the vehicle. In an operative or in-use position it is located laterally of the vehicle body and in a folded or parked position is located approximately parallel to the side of the vehicle so as to prevent damage to the mirror and mirror housing. Such a folded position is useful when the vehicle is parked on narrow roadways or being taken through a car wash.

Motorised versions which fold mirrors in the manner described above are referred to as power fold mirrors and can be arranged with appropriate control electronics to move to a folded position when a button is pressed or upon the vehicle's ignition being turned off or alternatively the gear selector being placed in the parked position.

It is typical at this time for the motor used to drive the folding mechanism to be provided power until the current driving the motor is raised substantially above normal levels (over current) for a predetermined period of time. This can result from the mirror head coming against a stop. This manner of motor control is cheap to design, but not necessarily cheap to build and typically needs to include expensive

transient suppression components. An alternative is to use expensive and potentially unreliable limit switches.

Furthermore, periods of over current are an undesirable feature of prior power fold mirror designs as this can ultimately lessen the life of the electric motor and its associated drive train components or can cause unexpected failure. Yet furthermore, as the effects of spurious electromagnetic (EM) emissions are sometimes unpredictable, especially upon vehicle electronic systems, it is advantageous to eliminate or keep to an acceptable minimum this type of emission.

It is also typical that the motor used to drive powered mirrors are direct current (d.c.) motors which require a specific polarity of current to drive them in a desired direction and this tends to complicate the design of typical motor drive circuits.

It is an aim of this invention to eliminate or reduce the abovementioned problems.

BRIEF DESCRIPTION OF THE INVENTION

In a broad aspect of the invention, a motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein said motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to said motor, said motor control circuit comprising,

a pair of unipolar control circuits wherein a respective one of each unipolar control circuits is connected between a respective current source and a current input to said motor wherein a respective unipolar control circuit which is adapted to operate said motor in one of said two directions,

a motor control circuit according to claim 1 wherein each of said unipolar control circuits are substantially identical.

a motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises,

a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

current limiting means for adjusting said input bias signal according to the current flowing through said motor, such that said switching means adjusts said input bias to said solid state switch such that less current flows through said motor when a predetermined period of current limiting has occurred, and

a motor control circuit according to claim 3 wherein said current limiting means further comprises a temperature compensation circuit.

Specific embodiments of the invention will now be described in some further detail with reference to and as illustrated in the accompanying figures. These embodiments are illustrative, and not meant to be restrictive of the scope of the invention. Suggestions and descriptions of other embodiments may be included but they may not be illustrated in the accompanying figures or alternatively features of the invention may be shown in the figures but not described in the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig 1 depicts a functional block diagram of a motor control circuit according to one embodiment of the invention, incorporating a circuit for each direction of motor operation;

Fig 2 depicts a circuit of both unipolar circuits for controlling the motor;

Fig 3 depicts the portion of one of the unipolar circuits which is functional during normal running of the motor as it actuates the motor between a first and second position;

Fig 4 depicts the portion of one of the unipolar circuits which is used to limit the current provided to the motor as well as temperature compensate the current limiting function; and

Fig 5 depicts the portion of one of the unipolar circuits which is used to abruptly cut off current to the motor after a period of current limiting.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

Fig 1 depicts a functional block diagram of a motor control circuit which has been found useful to control a motor used to actuate the folding and un-folding of a mirror housing between an extended and folded position.

However, any motor which has the task of moving an element between two positions could be controlled by such a circuit. Thus, even though the description provided herein is directed to vehicular outside rear view mirrors and their fold back function, the circuit is capable of being applied to motors required to provide similar movement.

The motor 10 is located between a positive (+) and negative (-) source of electrical current and dependent on the polarity of current applied to the motor the shaft of the motor will turn in a predetermined direction. Thus to change the direction of the motor, the supply current polarity is swapped, which can be easily done by controlling the position of a vehicle driver-operated switch or switch-like device (not shown).

In the example of an outside rear view mirror housing which is foldable relative to the vehicle body between a folded position and a lateral position, a single electric motor can be connected to a mechanical means for translating the rotational motion of the motor's shaft into a movement of the mirror housing between the described positions.

In the past when the mirror housing reached the end of its travel, the motor, which is controlled with a dual polarity control circuit, would draw large amounts of current until the relatively high current being drawn was detected and used to trigger the cut-off of the supply current.

As will be provided in more detail in this application, the described embodiment of the invention illustrates features which simplify and facilitate an alternative way to control an electric motor in this example as used in a foldable vehicular outside rear view mirror.

In this invention there is use of a novel topology which includes two unipolar electronic circuits. The motor is always in circuit whether the polarity is positive or negative and the motor drive circuits are symmetric.

Also, in this invention, one approach is to switch off current to the motor after current to the motor has been limited to a maximum level for a predetermined time.

However, this is but one preferred characteristics of the motor control arrangement for determining when to switch off or substantially reduce power to the motor.

In the preferred embodiment of this invention, the circuit used to sense electric motor current usage is by way of sensing the drop of voltage across a shunt resistor with a bipolar transistor which will turn on at a predetermined voltage level.

Fig 1 depicts two unipolar circuits one each side of the motor 10. Only one side of the circuit diagram will be described as the other side is identical. The opposite side of the circuit comes into operation upon a change of the polarity of the source current. However, it will be apparent that there is always a conduction path

through the opposite side to that which is operational so as to complete the circuit back to the current source.

A solid state switch 12 is located between one of the current inputs 14 of the motor 10 and the current source.

This switch 12 is used to control the amount of current which flows through the motor as well as to switch off current to the motor once a predetermined position or the end of travel has been reached, as is the typical case or when a switch off characteristic is detected.

A current limiting circuit 16 is located between the switch 12 and the source of current, in this case a positive current terminal. To provide consistency of operation over a reasonable environmental temperature variation, a temperature compensation circuit 18 is provided, but this is an option rather than a necessity for the operation of such a motor in the majority of circumstances.

During normal operation of the motor, the switch 12 is controlled by bias control circuit 20 which ensures that the switch is set so as to pass current directly to the motor 10.

Once the mirror housing or element actuated by the motor has reached the end of its travel a prompt cut-off of current to the motor is desirable and cut-off circuit 22 performs this function based on a predetermined period of active current limiting which is provided by circuit 16 once the end of travel is approaching or reached.

In one example, when the motor is detected drawing much more current than is required to drive the motor and a predetermined threshold current is exceeded for a predetermined time, motor current switch off is initiated.

Fig 2 depicts a complete circuit for a foldable vehicular external rear view mirror housing motor RM. The circuit is substantially symmetric so that one side can operate when one polarity of current is applied and other side can operate when the opposite polarity of current is applied. The common components being R1 and R2.

Fig 3 depicts those components of the circuit which are primarily active during the application of current such that terminal X4 has a positive polarity and the motor RM is running.

Current flows through the diode of Q4 (a parasitic diode which is available in transistors of this general type), through the motor RM, through Q1 and through current sense resistors R8 and R9. This diode provides reverse current blocking and over voltage protection but in other circuit configurations, a Zener diode of suitable characteristics could be across the output devices. In the preferred embodiment solid states switches Q1 and Q4 are each a Metal Oxide Silicon Field Effect Transistor (MOSFET) semi-conductor transistor device.

Switching transistor Q1 is the same as Q4 and is biased into conduction through its source and sink by a voltage supplied via D1, R1, R2 and R4. This voltage is sufficient to turn-on Q1 so that sufficient current can flow through the motor to drive the mechanism to which it is mechanically coupled.

It is merely preferable that current limiting is provided in this circuit configuration as it is equally possible to not have current limiting and allow the current to be controlled by the motor. For example, it is possible to detect the

magnitude of the current being drawn and if the magnitude exceeds a predetermined level for a predetermined time, initiates switch off of the current. Both approaches rely on the motor current wherein detection is the same but one also limits the current.

Fig 4 depicts those particular components of the circuit which are primarily active during the function of limiting current through the motor, but this is incidental to the end of travel detection.

Thus for the current limiting approach during normal operation, the current through R8 and R9 is such that the base voltage on Q3 is insufficient to cause Q3 to conduct between its collector and emitter. However, as the level of current flowing through the motor increases, the voltage on the base of Q3 increases and Q3 will begin to turn-on and conduct. As Q3 conducts more current, there is a reduction of on-bias of the main current switch Q1 via R4. Q1 thus conducts less current and current to the motor RM is thereby limited.

It is preferable however that the current limiting process be substantially consistent even with fluctuating temperature. Temperature compensation can be provided to accommodate a drive voltage of the main bipolar transistor Q1 which changes by approximately -1% for every +3°C.

In this embodiment collector current Q3 is provided via a thermistor R2 which has a negative temperature co-efficient. Thus as the ambient and component temperature rises, the current through the thermistor increases and the collector current through Q3 increases which partly off-sets the falling base voltage in Q3.

The increase in current through the thermistor R2 with increasing temperature will cause an increased voltage across R7. This voltage reduces the voltage

appearing across the base emitter junction of Q3. The effect is to off-set the reduction in base emitter voltage required by Q3 with increased temperature. R7, R2 and R1 are chosen to give a best fit current versus temperature curve. R1 limits the maximum current that can flow when very high temperatures are experienced by the system. It is worth noting that temperature compensation can be used to produce other than flat responses to accommodate for material softening etc in the mechanics.

Referring to Fig 5, when current limiting is occurring, the voltage across the solid state switch Q1 increases, hence reducing the voltage across the motor and with it the current. As the voltage across Q1 increases it also charges C1 via R3. Over a period of time C1 charges to a voltage such that Q2 turns-on and begins to conduct which in turn reduces the drive voltage of the main transistor solid state switch Q1.

This process accelerates as the period of current limiting increases and as current is reduced further the voltage across Q1 increases but raises the relative level of the base voltage on Q2 which in turn conducts more and thus brings down sharply the bias voltage applied to the main bi-polar transistor solid state switch Q1. This condition quickly reduces to substantially zero the conduction through Q1 and thereby the current flow which operates the motor.

R4 is chosen to keep to a minimum the current drawn by the circuit while Q1 is in the off-state.

With the exception of small bias currents, all primary current paths are conducted through the motor which is advantageous since transient voltage excursions from the supply are limited by the resistance and induction of the motor windings. A consequence of this design feature is that there is a reduced need for transient protection components.

A further advantage of the preferable circuit design, is the use of current limiting and the period of current limiting being used to determine the cut-off condition for current flowing through the motor. This is likely to result in less stress (mechanical and electrical) upon the motor when the mechanism to which it is connected reaches the end of its travel and also improves the Mean Time Between Failure (MTBF) of the motor actuated element.

A yet further advantage of the preferable circuit is the small quiscent current drawn once the MOSFET switch is turned off as indicated in relation to the selection of the value of R4.

Even though the circuit is arranged to detect an increasing current condition through the motor it does not necessarily know if this condition has occurred because the mechanism it actuates has actually reached one of its end of travel positions. Such a condition could occur if the mechanism is stopped unexpectedly intermediate its end of travel positions. Other sensors and circuits can then be used to ensure that the intended end of travel position has in fact been reached but these issues are not central to the problem addressed by the invention disclosed in this specification.

It will be appreciated by those skilled in the art, that the invention is not restricted in its use to the particular application described and neither is the present invention restricted in its preferred embodiment with regard to the particular elements and/or features described or depicted herein. It will be appreciated that various modifications can be made without departing from the principles of the invention, therefore, the invention should be understood to include all such modifications within its scope.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A motor control circuit for a direct current electric motor having a pair of direct current inputs supplied respectively from negative and positive current sources wherein said motor is actuated to turn a shaft in one of two directions dependant on which polarity of current is being provided to said motor, said motor control circuit comprising,

a pair of unipolar control circuits wherein a respective one of each unipolar control circuits is connected between a respective current source and a current input to said motor wherein a respective unipolar control circuit which is adapted to operate said motor in one of said two directions.

2. A motor control circuit according to claim 1 wherein each of said unipolar control circuits are substantially identical.

3. A motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises

a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

current limiting means for adjusting said input bias signal according to the current flowing through said motor, such that said switching means adjusts said input bias to said solid state switch such that less current flows through said motor when a predetermined period of current limiting has occurred.

4. A motor control circuit according to claim 3 wherein said current limiting means further comprises a temperature compensation circuit.

5. A motor control circuit according to claim 4 wherein said temperature compensation circuit comprises a thermistor having a negative temperature co-efficient located in said circuit so that as the ambient temperature and control circuit temperature rises the current through the thermistor increases and said input bias signal to said solid state switch is compensated.

6. A motor control circuit according to claim 3 wherein said switch means is arranged to not operate said motor when said current limiting is occurring for a further predetermined period of time.

7. A motor control circuit according to claim 3 wherein said switch means is arranged to not operate said motor when current drawn by said motor exceeds a predetermined threshold current for a predetermined period of time.

8. A motor control circuit according to claim 3 wherein said current limiting means comprises

a motor current sensing circuit comprising a shunt resistor arranged to carry a proportion of the current flowing through said motor and provide a respective voltage to the base of a bipolar transistor which is arranged to turn on at a predetermined voltage level representative of the current flowing through said motor at which it should be switched off, such that said bipolar transistor turns on when said predetermined voltage level is reached and which decreases the input bias to said solid state switch to lessen the current through said motor.

9. A motor control circuit according to claim 1 wherein each of the other of said pair of unipolar control circuits conducts current to complete the circuit to allow said motor to operate.

10. A motor control circuit according to claim 1 wherein each of said unipolar control circuits further comprises

a solid state switch located between a said motor current input and said source of direct current wherein the degree to which said solid state switch allows current to flow to said motor is controlled by an input bias signal to said switch,

current detection means to detect the magnitude of current being drawn through said motor and if said magnitude exceeds a predetermined level for a predetermined time reduce said input bias signal to said switch.

11. A motor control circuit according to claim 1 wherein current is primarily conducted through said motor.

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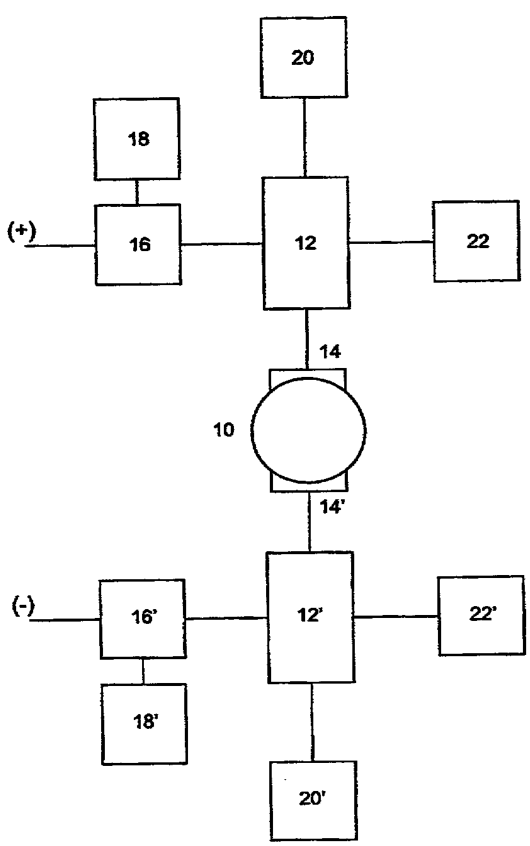
(54) Title: DIRECT CURRENT MOTOR CONTROL CIRCUIT



(57) Abstract: A motor control circuit for a direct current electric motor has a pair of direct current inputs supplied respectively from negative and positive current sources. The direction of travel of the rotor of the motor (10) is determined by the polarity of the current supplied to it. A new motor control circuit comprises a pair of substantially identical unipolar control circuits. Each of the unipolar control circuits being connected between a respective current source and a current input to the motor wherein a respective unipolar control circuit is adapted to operate said motor in one of said two directions. Each of the unipolar control circuits comprises a solid state switch (12) located between a motor current input and the source of direct current. The degree to which said solid state switch allows current to flow to the motor is controlled by an input bias signal to the switch. Current limiting for adjusting the input bias signal according to the current flowing through said motor is provided in one way of controlling the motor movement. The switch adjusts the input bias to the solid state switch such that less current flows through the motor when a predetermined period of current limiting has occurred. Also a current detection can be used to detect the magnitude of current being drawn through the motor and if the magnitude exceeds a predetermined level for a predetermined time, the input bias signal to the switch can be reduced.

WO 01/22569 A1

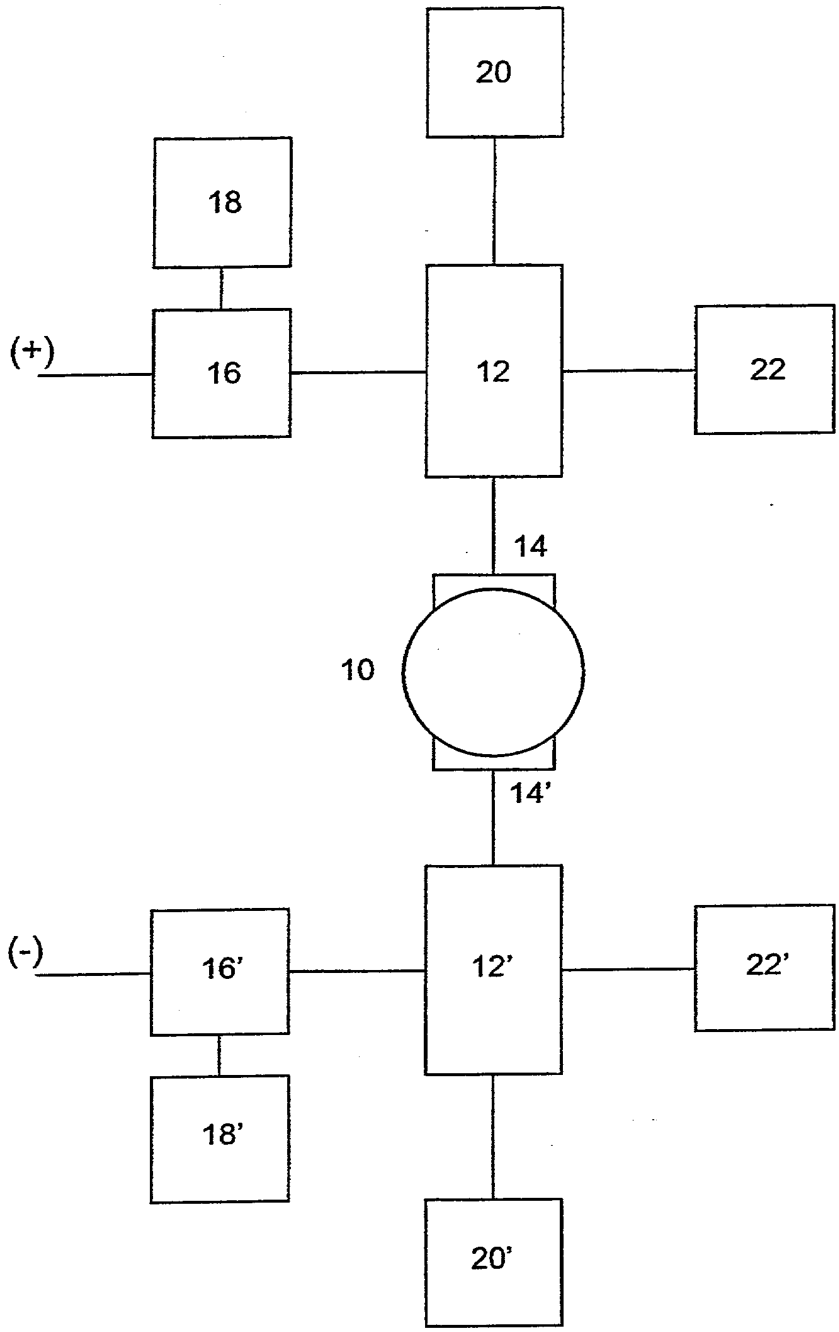
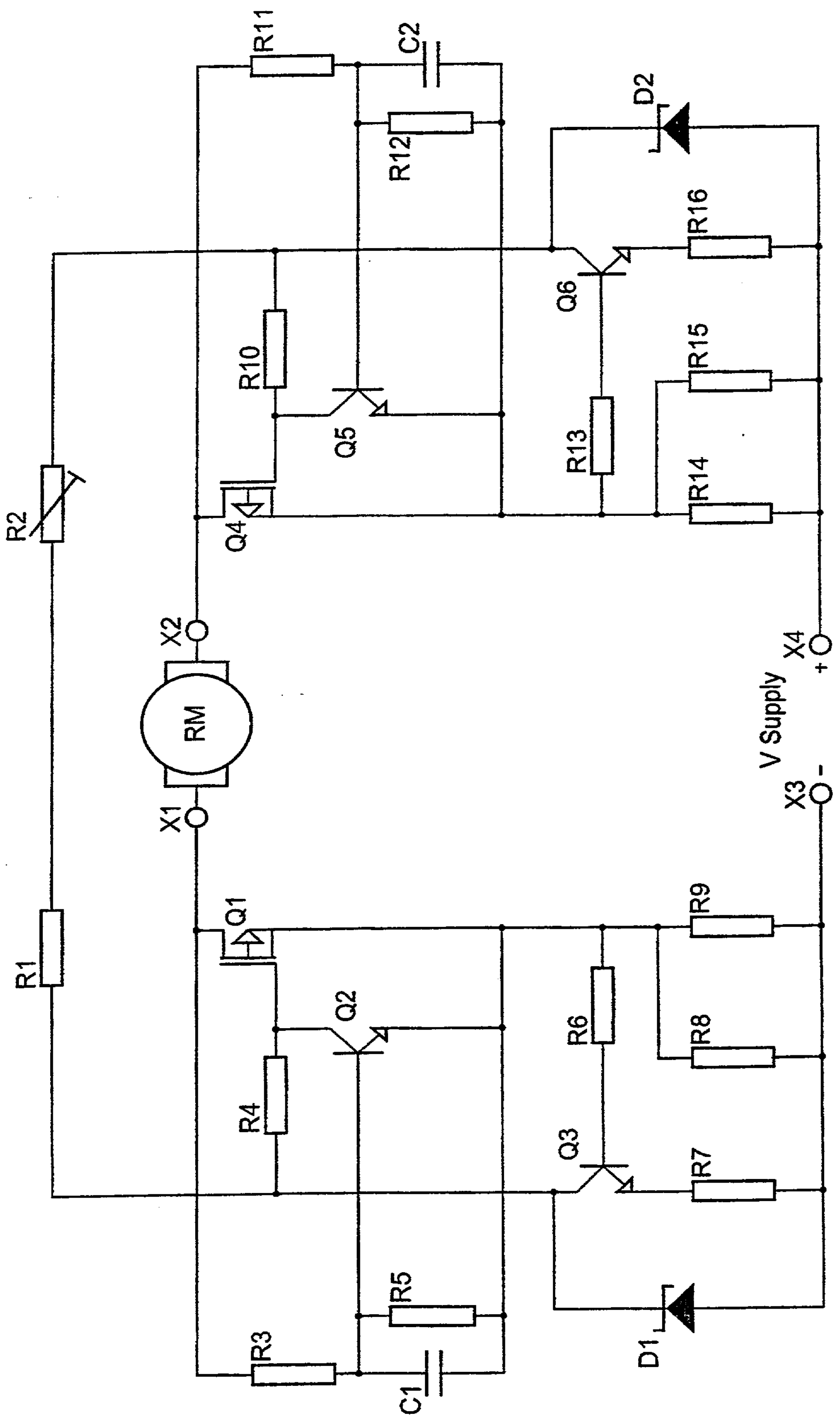


Fig 1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C2
R12
D2
R16
Q6
R10
Q5
R15
R13
R14
R2
Q4
X2
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X1
X4
V Supply
X3
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R3
D1
C1

Fig 2

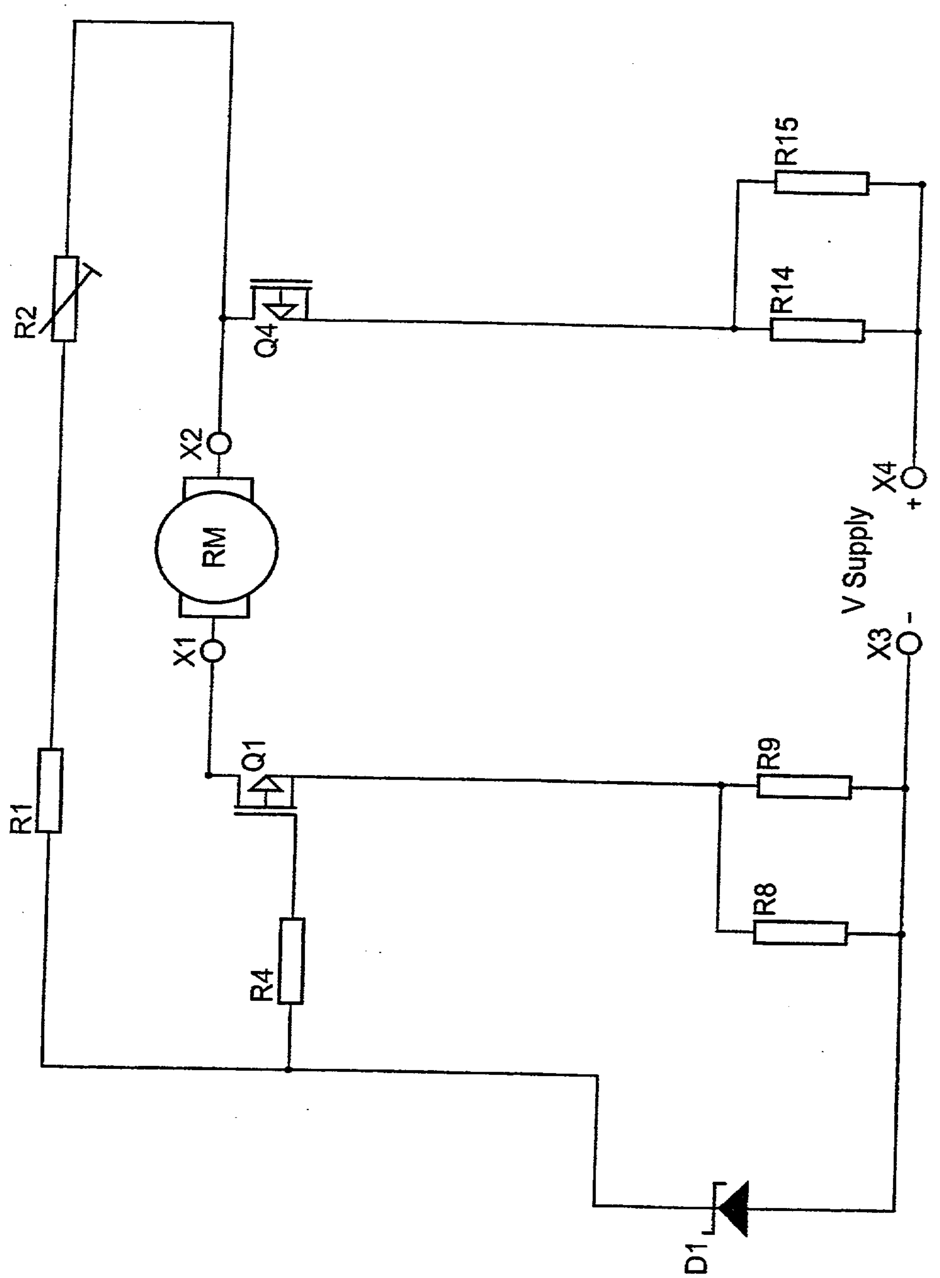

Fig 3

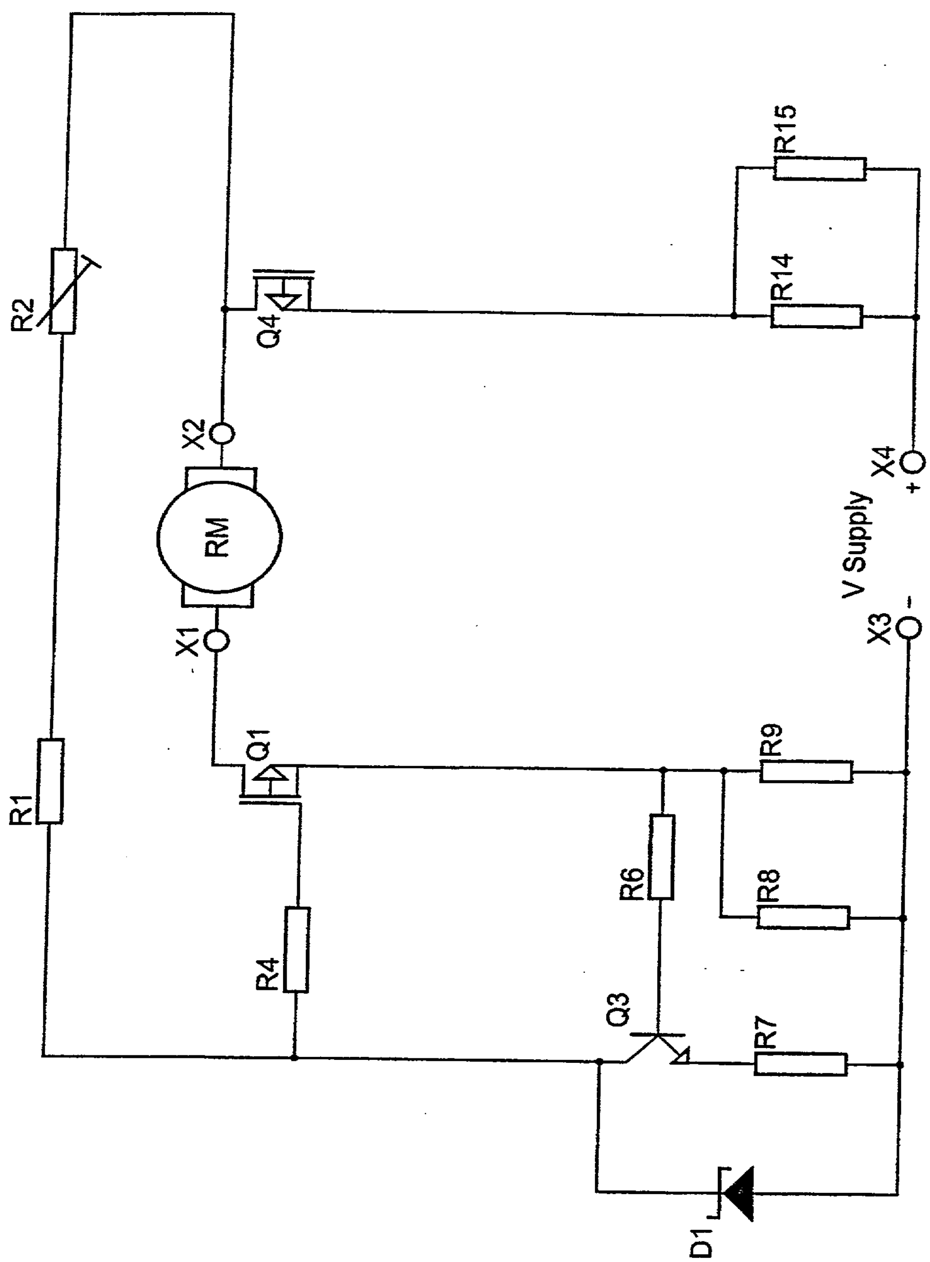

Fig 4

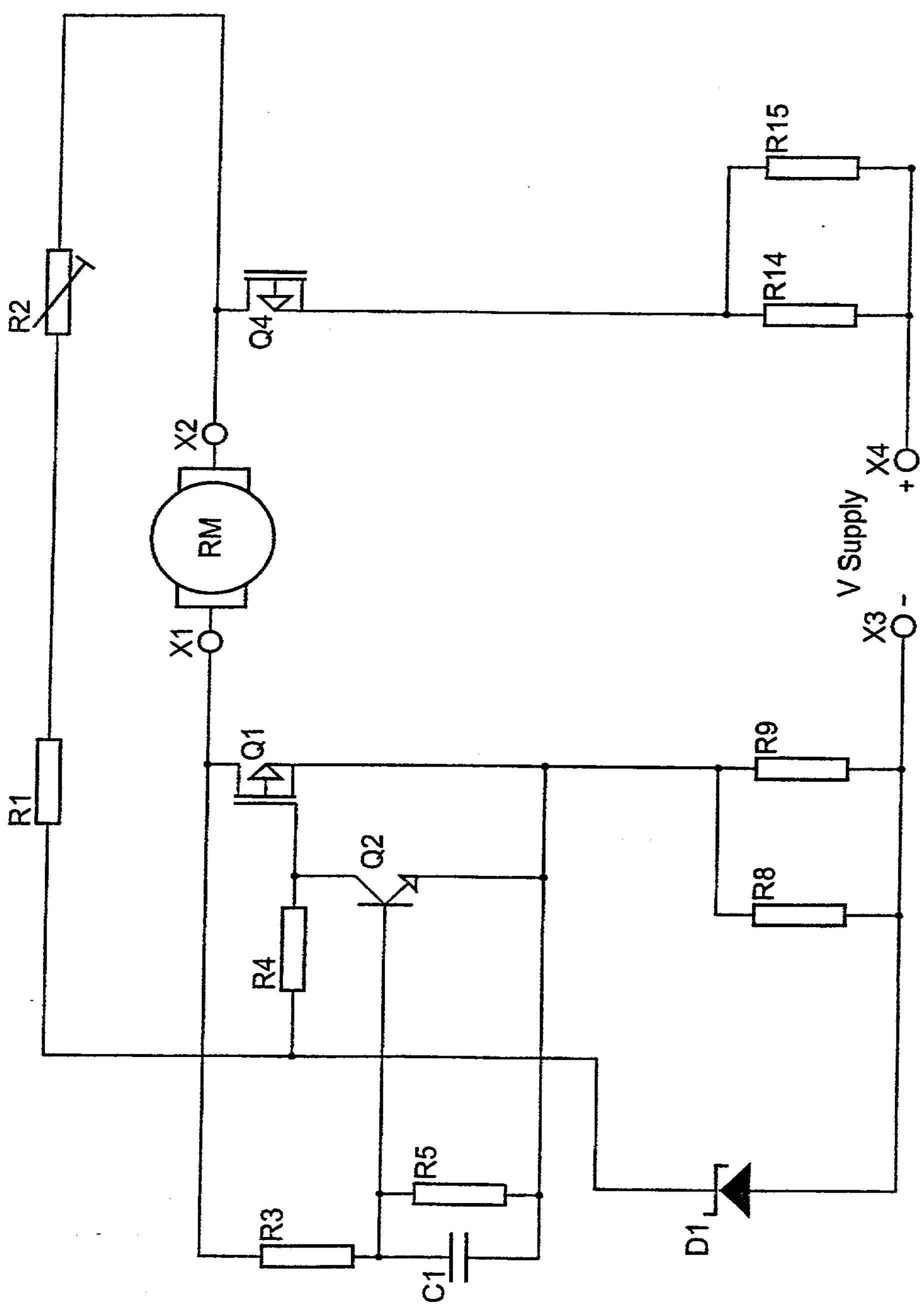

Fig 5

USA

BRI-00063

Attorney's Docket No:________

COMBINED DECLARATION/POWER OF ATTORNEY

AS BELOW NAMED INVENTOR, I HEREBY DECLARE THAT: This Declaration is of the following type:

______ Original	______Supplemental	______Continuation-In-Part
______Divisional	______ Continuation	__X__ National Stage of PCT

My residence, post office address and citizenship are below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: "DIRECT CURRENT MOTOR CONTROL CIRCUIT" the specification of which:

______is attached hereto
______was filed on , as Serial No
______was amended on (if applicable)
X__was described and claimed in PCT International Application No PCT/AU00/01142 filed on 20th September 2000

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Sec. 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Sec.119 of the foreign application(s) for patent or inventor's certificate or of any PCT International application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America files by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Country	Appln No.	Day/Month/Year/Filed	Priority Claimed Yes No
Australia	PQ 2940	20 September 1999	Yes
Australia	PQ 7577	18 May 2000	Yes

I hereby appoint the following attorneys and/or agents to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected with:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issue therefrom.

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